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Coupled Spin-Light dynamics in Cavity Optomagnonics SILVIA VIOLA KUSMINSKIY, Max Planck Institute for the Science of Light, HONG TANG, Yale University, FLORIAN MARQUARDT, Max Planck Institute for the Science of Light and University of Erlangen-Nuremberg — Very recent experiments have shown coherent photon-magnon coupling in the optical regime for the first time. In these experiments, an insulating ferromagnet is used both as the host of the magnetic excitations and as the optical cavity. Due to the mismatch of frequencies the optomagnonic coupling is parametric, unlike the resonant coupling to microwaves also demonstrated recently. In this theoretical work we derive the microscopic optomagnonic Hamiltonian starting from the Faraday effect. In the linear regime the system reduces to the well-known optomechanical case, with remarkably large coupling. Going beyond that, we discuss different regimes of light-induced nonlinear classical spin dynamics for a homogeneous magnon mode. In the fast cavity regime we obtain an effective equation of motion for the macrospin, and show that the light field induces a dissipative term reminiscent of Gilbert damping. The induced dissipation coefficient however can change sign on the Bloch sphere, giving rise to self-sustained oscillations. When the full dynamics of the system is considered, the system can enter a chaotic regime by successive period doubling of the oscillations. We discuss the experimental feasibility of these regimes and provide a qualitative phase diagram of the nonlinear dynamics.

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